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SHOW FILES; DS
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Set      Items    Description
S1       68077    CONSUMABLE?
S2       53897    LASER (1W) SYSTEM?
S3         102    ORDERING () COMPONENTS
S4     3620378    REPAIR? OR REPLACE?
S5           0    S1 AND S2 AND S3 AND S4
S6           0    S1 AND S2 AND S3
S7           0    S2 AND S3
S8     2318247    COMPONENTS
S9      949483    ORDERING OR REPLACING OR REPAIRING
S10         44    S1 AND S2 AND S8 AND S9
S11         23    S10 NOT PY>=2001
S12         19    RD (unique items)
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T S12/FULL/8

12/9/8 (Item 5 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)

07197459 Supplier Number: 61203158 (THIS IS THE FULLTEXT)
Requirements for next-generation gas-flow components.
Zarkar, Kaveh
Solid State Technology, v43, n3, p27
March, 2000
ISSN: 0038-111X
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Refereed; Trade
Word Count: 2880
TEXT:

Working down from anticipated device trends over the next five years to deposition and etch process needs, we can derive a comprehensive list of specification advances needed for mass flow control and other gas components. Clearly, most of these needs will require better execution of digital flow control, sensor buses, and other key technology.

Future industry process capabilities, particularly the emerging demand for chemical vapor deposition (CVD) and plasma etch, eventually work their way down to specific needs in gas flow control components. Indeed, the industry will require new and continuously improving generations of mass flow controllers (MFCs) along with other gas components if processes for advances in inter-metal dielectrics (IMD) and gate oxides, among others, are going to be available (see Table 1).

Because specifications are not the same for all gases and across different MFC manufacturers, "X" in Table 1 represents a typical performance specification for each category circa 1999. For example, the current stainless steel material (SS316L) will be sufficient for MFCs over the next 5 years (i.e., IX through 2004). Today's repeatability specification of 0.2% full scale needs to be improved to (less than)0.1% (2X) by year 2004 to accommodate performance demands associated with new shorter-step, lower-flow recipes. Turndown ratio of digital flow controller (DFCs) needs to be improved from today's 25:1 to 100:1 by 2004 (4X). Turn down ratio is a capability that allows a single range controller to be used over a wide dynamic range (e.g., a 0-1000 sccm MFC with a turndown ratio of 100:1 can be set and used at 0-10 sccm without precision loss).

A key industry trend affecting traditional gas system components is the continued shift from batch to single wafer processing and the associated switch to 300mm wafers. In general, low flow rate (i.e., (less than)3 sccm) etches and CVD processes will become more prevalent. On the other end of the gas-flow spectrum, some rapid thermal processing, particularly epitaxial deposition, will demand better control of high flow rates (100-300 slm). Related requirements will include the ability to control accurately the gas flow from a bulk gas source. The industry is adopting lower pressure bulk source specialty gases for reasons of safety and cost savings, because conventional high-pressure cylinders require more frequent change-outs.

Increased adoption of electrostatic chucks (ESCs) -- which hold a wafer using a backside pressure of a few torr -- in single-wafer processes that require lower and more precise flow of process gases due to gas load requirements can also Introduce flow control and process chamber pressure control complexities. The complexities associated with wafer chucking (i.e., backside wafer cooling and heating) in etch and CVD processes can have a major effect on flow rate and pressure control in the processing chamber if the backside pressure of an ESC is not controlled properly. Simply stated, any imbalance in process chamber pressure caused by ESC

control will affect the process gas load and process repeatability.

Also, the eventual integration of metrology and analytical capabilities with CVD and etch systems will certainly affect flow control schemes and requirements. The ultimate goal of the chamber control system is to control the gas constituency in the chamber. Using an in situ chamber gas analyzer (preferably a noncontact laser system), the gas constituency in the chamber could be measured in real time, affecting the gas flow upstream of the chamber rather than traditional "downstream" pressure control systems.

The development of new gas flow control components with the required end-user performance characteristics and selection criteria (see Table 2) must also adequately address the challenges that equipment suppliers face. Here, the new performance requirements must be met with components that are more robust and reliable, so they contribute to improved overall equipment effectiveness (QEE), helping to reduce system cost, consumable costs, and footprint, and contributing to safety and environmental goals. Any new gas control components must also address emerging uniform automation and communications protocols, so they do not hinder system and process integration trends, and must contribute to real-time process control capability.

Any manufacturer of gas components and gas panels used in wafer processing systems will look at industry trends and see that its major challenges, associated with the gases entering a process chamber, are to provide:

* gas filter technology with better retention across a lower pressure drop,
* the technology needed for accurate (less than)3 sccm mass flow control,
* 1-3mtorr low-pressure manometers (conventional capacitance diaphragm gauge technology might be pushing the envelope), and
* OEMs with "one size fits all" components (mainly MFCs, manometers and pressure transducers) that meet OEM, MTBF, and MTTR requirements.

Process technology development trends

Clearly, semiconductor manufacturing technology is migrating to lower process-pressure, high-density plasma deposition (HDP-CVD), to adoption of liquid source precursors for sub-atmospheric CVD (SA-CVD), to continued advances with low-k IMD materials, and toward the emergence of high-k gate dielectric materials. Generally, we expect to see higher process temperature recipes for CVD and etch. Associated with all these trends is the need for in-chamber gas monitoring and delivery control to provide a constancy of gas flow inside the process chamber. Direct liquid injection vaporizer subsystems are seriously needed to support the emerging use of new liquid precursors.

HDP-CVD, which is the preferred technique for IMD films, dictates that gas flow control technology must address lower deposition pressures and higher gas loads, shorter length process steps, and an array of changing dielectric chemistries. In addition, HDP systems bring an increased potential for particle generation from backstreaming from higher-temperature vacuum pumps and the use of high-temperature (200-250(degrees)C) positive-shut-off motor-driven gate valves that are required to prevent condensation. Higher-temperature vacuum components are dictated by increased application of copper, for example, whose reaction byproducts are not sufficiently volatile at conventional temperatures; with copper, process temperatures must be increased (requiring lower reactive gas flow) to increase reactivity and to reduce particle generation. Higher process temperatures also drive a need for high-temperature manometers with a range of 0-1mtorr.

Our study indicates that SACVD TEOS and (O.sub.3) will continue being the main technology for encapsulation of spin-on dielectric and capping layers for the next few generations of ICs. TEOS, like other possible

liquid precursors from bulk supply, requires continued development of direct liquid injection (DLI) technology. The fact that OEMs will be concentrating on such liquid precursors means that there will be many challenges for liquid source delivery via MFCs and vaporizer systems, because some of the new exotic liquid precursors have unstable liquid or vapor forms, making the delivery more challenging.

Better liquid source delivery technology will also be important for some of the new precursors being considered for both low-k and high-k dielectric applications (see Table 3). Some of these nongaseous precursors with an unstable phase will require special delivery systems not fully developed at this time. Ultimately, the vapor phase of these precursors must be precisely injected into a process chamber.

Increasingly, dielectric deposition schemes involve vaporizing liquids that are air-reactive. Successful delivery of these liquids depends on the stability of the vapors and carrier gas purity control.

The various new CVD precursors being considered present different flow control challenges (see Table 4). If a precursor has a stable vapor, it will require a vaporizer and a vapor-controlled MFC. If the liquid is not stable and does not have a stable vapor, however, delivery of the chemical into a process chamber will start with measurement of liquid mass and flow followed by vaporization into the chamber.

From Table 4, new chemical trends show that chemicals in category A, B, D, and E with flow rates of 1-1000 sccm and stable vapors will become dominant in dielectric, contact, adhesion, and barrier layer applications in the next few process generations. Ideally, these chemicals need a low-flow-rate, low-vapor-pressure ((less than)50 torr) MFC with a turndown ratio of 1000:1 to cover most of the vapor ranges with one component. Currently, today's analog MFCs are good for 20:1 ratio, but 100:1 or higher is needed with digital electronics to ensure resolution and precision. Encouragingly, the latest DFCs are getting closer to this goal.

From Table 4, new chemical trends show that chemicals in categories C and F with unstable vapors will become dominant for contacts and via hole applications, as well as dielectric layers, potentially replacing (WF.sub.6), (SiH.sub.4), (TiCl.sub.4), and (NH.sub.3) in the near future. These chemicals need DLI systems. In addition, requirements here call for a low-cost, common platform for liquid flow control; low-flow, low-pressure liquid and vapor filtration for solids in solution and vapor applications; filters for vapor phase liquids; and vaporizer system for the vapor delivery systems.

Safe Delivery Source (SDS) systems are also a point of focus for some of the new materials, mainly for environmental safety reasons. For example, most of the hydride gases for CVD and ion implant are being considered for SDS, which is basically a gas adsorbed on a substrate where delivery of the gas is only possible under vacuum conditions. SDS was mainly developed for ion implant, but is now moving very quickly into CVD applications. The low inlet pressure and the significant increase in pure dopant capacity (up to 20x more than conventional gas cylinders) will put this technology in the forefront of CVD and ion implant in the near future.

SDS gas component requirements include low-inlet-pressure ((less than)2 torr), low-pressure-drop MFCs to maximize (up to 95%) the usage of cylinder content.

We will also see an increased need for real-time, in-chamber gas monitoring in future gas control. In-chamber monitoring systems must have a common protocol for communications to the central control system for the tool. Therefore, they must have a sensor bus (particularly DeviceNet and ProfiBus) that is common to most of the tools to provide plug-and-play functionality. They should be network-ready gas panels that can basically interface with these devices. They must have self-diagnostic capability, as well as multifunctional components on the gas panels, which are the requirements for cost and footprint reduction. Multifunctional components

will combine functionality, such as filters or purifiers with a pressure transducer in one small package to reduce footprint and dead volume, reducing cost, size, and purge time.

D. R. Woolf, The Idea of History in Early Stuart England: Erudition, Idolatry, and "The Light of Truth" from the Accession of James I to the Civil War (Toronto: Univ. of Toronto Press, 1990), pp. 117-25, gives a more generous account of James's motives.

Etch technology development trends

High density plasma (HDP) etch is the overall choice for advanced dielectric, metal, and polysilicon etch applications. Here, (CIF.sub.3) and (NF.sub.3) are used for chamber cleaning, CO is widely used in etch recipes, (Cl.sub.2)-HBr and (Cl.sub.2)-(BCl.sub.3) for metal and polysilicon etch and (CHF.sub.3)-(O.sub.2) for dielectrics. Shallow trench isolation (STI) etch is gaining momentum for sub-250nm devices, where precise lower chamber pressure (3-20 mtorr) for the trench-main-etch and bottom-rounding-etch steps is required. Some new etch materials are being considered because they help reduce the greenhouse effect -- mainly (CF.sub.3)CF(H)(CF.sub.3) and (CF.sub.2)(IC.sub.2)(F.sub.5).

Some of the gas control capabilities needed to support the future of etch include in situ detection and characterization of plasma during etch process control for precise and repeatable etch rates given the chamber gas constituency. This will call for "interactive" manometers and MFCs capable of peer-to-peer communication over the field bus for the interrogation of the chamber pressure and self-zero adjustment.

MFC technology

Today, there are several MFC technologies available. Thermal MFCs are most typical and popular. Pressure-based MFCs are gaining in popularity in the industry. Sonic-nozzle MFCs have some limited use. MEMS-based MFCs are generally used with inert gases that are compatible with their silicon components.

Next-generation MFCs will have to be digital, rather than the analog MFCs that dominate the market today. Increased functionality will only come if digital MFCs provide improved accuracy through a digitally controlled valve, increased dynamic range ((greater than)100:1), elimination of overshoot and undershoot, etc. There is a broad range of attributes with DFCs that will help optimize accuracy and repeatability. DFCs will also provide the ability to store multiple gas curves in a calibration database storage and provide self-diagnostics to reduce tool downtime.

To elaborate on just a few of the attributes of DFCs, increase in dynamic range ((greater than)100:1) will allow higher accuracy levels in lower flow ranges using the same flow controller range (i.e., "one size fits all") for a wide range of operating flow ranges. In addition, DFCs with multiple gas curve capability will allow a user to select the proper gas type from a stored list, adding flexibility to the flow controller. (Today, as engineers responsible for parts are well aware, analog MFCs must be ordered for specific flow ranges and gases.)

While DFCs have been touted for several years now, a true multigas curve flow controller with process needs as identified above has been very slow to mature.

Currently most of the MFCs used in the marketplace are calibrated using the surrogate gases; this is done for cost, safety, and environmental issues. But the derived "correction factors" are often off by a significant percentage. While this might have been sufficient in the past, it will not suffice in the future. There is a major difference between the surrogate gas and actual gas, due to the specific heat and molecular weight differences between the two. So, as next-generation MFCs are designed, the requirements for calibrating these devices with the actual gas must be considered. As a minimum requirement for the future, we will need to confirm performance between surrogate and actual gases.

Conclusion

In the very near future, new designs of DFCs will be the heart of deposition and etch chamber process control. These DFCs will have to be capable of driving multiple gases with a wide dynamic range. They must also be able to communicate peer-to-peer and master-to-slave and have capability for distributed control under the DeviceNet and ProfiBus protocols. They should be able to receive signals from in situ chamber gas constituency monitors to control gas flow, eventually replacing conventional downstream pressure control techniques. This must all be done while meeting reliability and cost of ownership criteria for future gas panels.

Acknowledgments

Safe Delivery Source and SDS are registered trademarks of Advanced Technology Materials, Inc. (ATMI) and are exclusively licensed to Matheson Electronic Products Group for sale to the ion implant sector of the semiconductor industry.

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Needed improvements in MFC attributes compared to "typical" (i.e. "X") 1999 capabilities

Attributes	1999	2000	2001	2002	2004
Full scale	X	2X	5X	5X	5X
Turndown ratio	X	2X	2X	4X	4X
Step response	X	2X	5X	5X	5X
Accuracy	X	1X	1X	1X	2X
Repeatability	X	1X	2X	2X	2X
Pressure comp	X	2X	2X	5X	5X
Temp comp	X	1X	1X	1X	1X
Material	X	1X	1X	1X	1X
Value leak	X	1X	2X	3X	3X
Surface finish	X	1X	1X	1X	1X
Operation temp	X	2X	4X	4X	5X
Communication	X	2X	3X	3X	4X
Power	X	1X	1.5X	1.5X	1.5X

Source: Millipore

Current semiconductor equipment selection criteria

Criterion	Percent emphasis
COO and price	45
Performance	25
Global support	25
Continuning improvement	5

Source: SEMI

Low-and high-k materials are advancing with both gas and liquid sources

Material	k value	Deposition method
SiN	7	CVD
(SiO_2)	4	CVD
SiOF	3.3	CVD
Polyimide	3-3.5	Spin-on
Hydrogen silsesquioxane (HSQ)	3	Spin-on
Fluorinated polyimides	2.8	Spin-on
Methyl silsesquioxane (MSQ)	2.7	Spin-on
Organic polymers	2.3-2.7	Spin-on
Polyarylene ethers	2.6	Spin-on
Parylene F	2.3	CVD

Flouorinated	2.2	CVD
Teflon	2.1	CVD, spin-on
Silica aerogels	1.1-2.0	Spin-on
Air bridges	1.0	Subtractive processing

Material	Implication
SiN	Increased flow delivery accuracy
(SiO.sub.2)	Increased flow delivery accuracy
SiOF	Requires high-temperature values
Polyimide	DLI & better accuracy vaporizers
Hydrogen silsesquioxane (HSQ)	DLI & better accuracy vaporizers
Fluorinated polyimides	DLI & better accuracy vaporizers
Methyl silsesquioxane (MSQ)	DLI & better accuracy vasporizers
Organic polymers	DLI & better accuracy vaporizers
Polyarylene ethers	DLI & better accuracy vaporizers
Parylene F	Low flow & fast response DFCs
Flouorinated	Low flow & fast response DFCs
Teflon	TBD
Silica aerogels	DLI, low flow, fast response
Air bridges	TBD

CVD precursor chemical categories

Category	Flow rate	Vapor pressure	Stable?
A	Low	High	Yes
B	Low	Low	Yes
C	Medium	High	No
D	Low	High	Yes (pyrophoric)
E	High	High	Yes (corrosive)
F	Low	Low	No (solid)
G	Low	High	Yes (toxic)

Category	Precursor
A	TEOS, TMP, (TiCl.sub.4) TDMAT
B	(Ta.sub.2)(O.sub.5), TDEAT, TEASAT
C	Cu(I), TaN
D	DMAH
E	(HSiCl.sub.3), (TiCl.sub.4) (H.sub.2)(SiCl.sub.2)
F	BST, PLZT, SBT
G	(Ph.sub.3), (AsH.sub.3), (BF.sub.3)

PUBLISHER NAME: PennWell Publishing Co.
EVENT NAMES: *310 (Science & research)
GEOGRAPHIC NAMES: *1USA (United States)
PRODUCT NAMES: *3674000 (Semiconductor Devices)
INDUSTRY NAMES: BUSN (Any type of business); ELEC (Electronics)
SIC CODES: 3674 (Semiconductors and related devices)
NAICS CODES: 334413 (Semiconductor and Related Device Manufacturing)
SPECIAL FEATURES: LOB
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S35	1	("705"/$$).ccls. and (@ad<"20000323").ad. and life and component and repair and (pulse adj count or tube adj window$1 or optical adj component or line adj narrowing adj module or monitor adj optics or halogen adj filter or laser adj gas)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/14 18:14

S36	3	("705"/$$).ccls. and (@ad<"20000323").ad. and life and component and repair and (pulse adj count or workpiece$1 or input adj energy or laser adj tube or tube adj window$1 or monitor adj optics or halogen adj filter or laser adj gas)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/14 18:17
S37	0	("705"/$$).ccls. and (@ad<"20000323").ad. and life and component and repair and workpiece$1 and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/14 18:18
S38	0	("705"/$$).ccls. and (@ad<"20000323").ad. and life and component and repair and workpieces and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/14 18:18
S39	0	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component and estimat$4 same (repair$3 or replac$5) and (payment$1 or fees or costs or billing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 11:06
S40	7	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:33
S41	3	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and parameter$1 same (time or pulse adj count or input adj energy or energy and discharge or workpieces)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:47
S42	2	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and parameter$1 same (time or pulse adj count or input adj energy or energy and discharge or workpieces) and module	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 13:43

S43	51	("372"/$$).ccls. and (@ad<"20000323").ad. and line adj narrow$3 adj module$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 13:44
S44	1	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and line adj narrow$3 adj module$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:19
S49	132	("372"/$$).ccls. and (@ad<"20000323").ad. and predict$4 and (replac$$6 or repair$3) and (consumable$ or components) and (pricing or Price or prices or cost or cposting or costs or fee or fees or charge or charges)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:36
S50	140	("372"/$$).ccls. and (@ad<"20000323").ad. and predict$4 and (replac$$6 or repair$3) and (consumable$ or component$1) and (pricing or Price or prices or cost or cposting or costs or fee or fees or charge or charges)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:38
S51	2	("372"/$$).ccls. and (@ad<"20000323").ad. and (life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and parameter$1 same (time or pulse adj count or input adj energy or energy and discharge or workpieces) and S50	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:37
S52	0	("372"/$$).ccls. and (@ad<"20000323").ad. and predict$4 and (replac$$6 or repair$3) and (consumable$ or component$1) and (pricing or costing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:38
S53	0	("372"/$$).ccls. and (@ad<"20000323").ad. and predict$4 and (replac$6 or repair$3) and (consumable$ or component$1) and (pricing or costing)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:39

S54	0	("372"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing) and (replac$6 or repair$3) and (consumable$ or component$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:41
S55	0	("372"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) and (pricing or costing) same (consumable$ or component$1) and (replac$6 or repair$3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:42
S56	9	("372"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) and (pricing or costing or prices or costs or fees or charges) same (consumable$ or component$1) and (replac$6 or repair$3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:44
S57	166	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) and (pricing or costing or prices or costs or fees or charges) same (consumable$ or component$1) and (replac$6 or repair$3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:45
S58	34	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (consumable$ or component$1) and (replac$6 or repair$3)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:52
S59	3	(life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and parameter$1 same (time or pulse adj count or input adj energy or energy and discharge or workpieces) and S58	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:49
S60	1	(life or lifetime or life adj cycle) same component$1 and estimat$4 and (repair$3 or replac$5) and (payment$1 or fees or costs or billing) and parameter$1 same (time or pulse adj count or input adj energy or energy and discharge or workpieces) and S58 and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 14:52

S61	4	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (consumable$ or component$1) and (replac$6 or repair$3) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:43
S62	4	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (consumable$ or component$1) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:37
S63	47	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) and (consumable$ or component$1) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:38
S64	20	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) and (replac$6 or repair$3) same (consumable$ or component$1) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:48
S65	11	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (replac$6 or repair$3) and (consumable$ or component$1) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:50
S66	2	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (replac$6 or repair$3) same (consumable$ or component$1 or equipment) and laser	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:50

S67	10	("705"/$$).ccls. and (@ad<"20000323").ad. and (predict$4 or forecast$3 or estimat$4) same (pricing or costing or prices or costs or fees or charges) same (replac$6 or repair$3) same (consumable$ or component$1 or equipment)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/16 15:51

L49	1	"5216612" and buyer	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 15:01
L50	638003	"5216612" and bill or pay pr fee	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 15:02
L51	249855	"5216612" and bill or purchas$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 15:02
L52	9	"5216612" and bill and purchas$3	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 15:02
S1	11077	("705"/$$).ccls. and (@ad<"20000323").ad. cost and allocat$3 and laser and lifetime and repair	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:49
S2	10965	("705"/$$).ccls. and (@ad<"20000323").ad. cost and allocat$3 and excimer same laser and repair and consum$5 and components and (predict$3 or forecast$3) same lifetime	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:52
S3	10964	("705"/$$).ccls. and (@ad<"20000323").ad. (cost$3 or pric$3) and allocat$3 and excimer same laser and repair and consum$5 and replac$4 adj components and (predict$3 or forecast$3) same lifetime	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:48
S4	10964	("705"/$$).ccls. and (@ad<"20000323").ad. (cost$3 or pric$3) and allocat$3 and excimer same laser and repair and consum$5 and replac$4 adj components and (predict$3 or forecast$3) adj (lifetime or costs or price or prices)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:57

S5	0	("705"/$$).ccls. and (@ad<"20000323").ad. and (cost$3 or pric$3) and allocat$3 and excimer same laser and repair and consum$5 and replac$4 adj components and (predict$3 or forecast$3) adj (lifetime or costs or price or prices)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:49
S6	3	("705"/$$).ccls. and (@ad<"20000323").ad. and cost and allocat$3 and laser and lifetime and repair	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:49
S7	0	("705"/$$).ccls. and (@ad<"20000323").ad. and cost$3 and allocat$3 and excimer and laser and repair and consum$5 and components and (predict$3 or forecast$3) and lifetime	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:51
S8	0	("705"/$$).ccls. and (@ad<"20000323").ad. and (cost$3 or pric$3) and allocat$3 and excimer and laser and repair$3 and consum$5 and replac$4 and components and (predict$3 or forecast$3) same (lifetime or costs or price or prices)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:52
S9	1	("705"/$$).ccls. and (@ad<"20000323").ad. and (cost$3 or pric$3) and allocat$3 and excimer and laser and repair$3 and consum$5 and replac$4 and components and (predict$3 or forecast$3) same (life or costs or price or prices)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/14 18:03
S10	1	("705"/$$).ccls. and (@ad<"20000323").ad. and (cost$3 or pric$3) and allocat$3 and excimer and laser and repair$3 and consum$5 and replac$4 and components and (predict$3 or forecast$3) same (life or costs or price or prices)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:52
S11	10964	("705"/$$).ccls. and (@ad<"20000323").ad. cost and allocat$3 and excimer same laser and repair and consum$5 and components and (predict$3 or forecast$3) same life	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/04 12:53

Ref #	Hits	Search Query	DBs	Default Operator	Plurals	Time Stamp
L1	0	("372"/$$).ccls. and (@ad<"20000323").ad. and (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:40
L2	0	("372"/$$).ccls. and (@ad<"20000323").ad. and (transaction or pay or paying or payment$1 or billing) same (maintenance or repair or repair$3 or replace or replacement) same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:30
L3	12	("372"/$$).ccls. and (@ad<"20000323").ad. and (transaction or pay or paying or payment$1 or bill$3) and (maintenance or repair or repair$3 or replace or replacement) same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:36
L4	70	("372"/$$).ccls. and (@ad<"20000323").ad. and (transaction or pay or paying or payment$1 or bill$3 and pre adj pay$5) and (maintenance or repair or repair$3 or replace or replacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:36
L5	2	("372"/$$).ccls. and (@ad<"20000323").ad. and (transaction or pay or paying or payment$1 or bill$3 and pre adj pay$5) same (maintenance or repair or repair$3 or replace or replacement)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:37
L6	4	("372"/$$).ccls. and (@ad<"20000323").ad. and (pay or paying or payment$1 or bill$3 and pre adj pay$5) and (maintenance or repair or repair$3 or replace or replacement) and component and equipment	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:40
L7	0	("372"/$$).ccls. and (@ad<"20000323").ad. and shedul$3 adj (pay or paying or payment$1 or bill$3 and pre adj pay$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:40

L8	0	("372"/$$).ccls. and (@ad<"20000323").ad. and schedul$3 adj (pay or paying or payment$1 or bill$3 and pre adj pay$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:40
L9	113	("705"/$$).ccls. and (@ad<"20000323").ad. and (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:42
L10	0	("705"/$$).ccls. and (@ad<"20000323").ad. and schedul$3 adj (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:43
L11	4	("705"/$$).ccls. and (@ad<"20000323").ad. and (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) same failure same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:56
L12	28	("705"/$$).ccls. and (@ad<"20000323").ad. and (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) and failure same (equipment or components or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:46
L13	4	("705"/$$).ccls. and (@ad<"20000323").ad. and (payment or pay or paying or payments or billing) same (maintenance or repair or repair$3 or replace or replacement) and (equipment or components or parts) adj failure	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:46
L14	938	("705"/$$).ccls. and (@ad<"20000323").ad. and prepay or pre Adj pay	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 13:57

L15	5	("705"/$$).ccls. and (@ad<"20000323").ad. and (prepay$4 or pre Adj pay$4) and schedul$2 adj payment$1 and (repair$3 or maintain$4 or replace$6)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:02
L16	6	("705"/$$).ccls. and (@ad<"20000323").ad. and (prepay$4 or pre Adj pay$4) and schedul$2 adj payment$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:02
L17	11246	("705"/$$).ccls. and (@ad<"20000323").ad. schedul$2 adj payment$1	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:03
L18	11010	("705"/$$).ccls. and (@ad<"20000323").ad. schedul$3 same payment$1 same predetermined adj time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:04
L19	10996	("705"/$$).ccls. and (@ad<"20000323").ad. payment$1 adj predetermined adj time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:04
L20	1	("705"/$$).ccls. and (@ad<"20000323").ad. and payment$1 adj predetermined adj time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:05
L21	64	("705"/$$).ccls. and (@ad<"20000323").ad. and payment$1 same predetermined adj time	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:06
L22	43	("705"/$$).ccls. and (@ad<"20000323").ad. and payment$1 same predetermined adj time and (equipment or component$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:08
L23	1	("705"/$$).ccls. and (@ad<"20000323").ad. and payment$1 same predetermined adj time same (equipment or component$1 or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:07
L24	0	("705"/$$).ccls. and (@ad<"20000323").ad. and scheduled adj payment$1 same predetermined adj time and (equipment or component$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:08

L25	0	("705"/$$).ccls. and (@ad<"20000323").ad. and scheduled adj payment$1 same (equipment or component$1 or parts)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:08
L26	21	("705"/$$).ccls. and (@ad<"20000323").ad. and scheduled adj payment$1 and (equipment or component$1 or parts or machinery)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:09
L27	7	("705"/$$).ccls. and (@ad<"20000323").ad. and scheduled adj payment$1 and (equipment or component$1 or parts or machinery) same (repair or replacement or maintenance)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:10
L28	76	("705"/$$).ccls. and (@ad<"20000323").ad. and payment$1 same (equipment or component$1 or parts or machinery) same (repair or replacement or maintenance)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:12
L29	0	("705"/$$).ccls. and (@ad<"20000323").ad. and (prepayment$1 or scheduled adj payments or prepay) same (equipment or component$1 or parts or machinery) same (repair or replacement or maintenance)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:12
L30	50	("705"/$$).ccls. and (@ad<"20000323").ad. and (prepayment$1 or scheduled adj payments or prepay or billed or billing) same (equipment or component$1 or parts or machinery) same (repair or replacement or maintenance)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:15
L31	138	("705"/$$).ccls. and (@ad<"20000323").ad. and (prepayment$1 or scheduled adj payments or prepay or billed or billing) same (repair or replacement or maintenance) and (equipment or component$1 or parts or machinery)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:16
L32	131	("705"/$$).ccls. and (@ad<"20000323").ad. and (costs or prepayment$1 or scheduled adj payments or prepay or billed or billing) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:17

L33	85	("705"/$$).ccls. and (@ad<"20000323").ad. and costs same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:18
L34	57	("705"/$$).ccls. and (@ad<"20000323").ad. and costs same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery) and (bill$3 or pay$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:18
L35	68	("705"/$$).ccls. and (@ad<"20000323").ad. and (costs or fees or charges) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery) and (bill$3 or pay$5)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:21
L36	68	("705"/$$).ccls. and (@ad<"20000323").ad. and (costs or fees or charges) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery) and (bill$3 or pay$5 or prepay or payment)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:22
L37	68	("705"/$$).ccls. and (@ad<"20000323").ad. and (costs or fees or charges) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery) and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:23
L38	68	("705"/$$).ccls. and (@ad<"20000323").ad. and (costs or fees or charges) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery) and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1 or recurring adj costs)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:34
L39	139	("705"/$$).ccls. and (@ad<"20000323").ad. and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1 or recurring adj costs) same (repair or replacement or maintenance) same (equipment or component$1 or parts or machinery)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:37

L40	504	("705"/$$).ccls. and (@ad<"20000323").ad. and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1 or recurring adj costs) same (repair or replacement or maintenance)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:43
L41	20	("705"/$$).ccls. and (@ad<"20000323").ad. and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1 or recurring adj costs) same (repair or replacement or maintenance) same parts	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:43
L42	2	("705"/$$).ccls. and (@ad<"20000323").ad. and (bill$3 or pay$5 or prepay or payment$s or scheduled adj payment$1 or recurring adj costs) same (repair or replacement or maintenance) same parts same failure	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:45
L43	1	"5216612" and (payment)	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:47
L44	3	"5216612" and bills	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:48
L45	0	"5216612" and bills and pay	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:48
L46	0	"5216612" and bills and payment	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:48
L47	0	"5216612" and bills and charge	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:49
L48	0	"5216612" and bills and fee	US-PGPUB; USPAT; USOCR; EPO; JPO; DERWENT	OR	OFF	2005/03/21 14:49